The Host Plant and Pre-imaginal Stages of *Actias callandra* (Saturniidae) from the Andaman Islands, India

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Abstract. The pre-imaginal stages of *Actias callandra*, a silk moth endemic to the Andaman Islands, are described and figured in color for the first time. The larvae were reared to maturity on *Lannea coromandelica* (Anacardiaceae); another possible hostplant is *Rhizophora*. The cocoon apparently has no sericultural value. It is proposed that *A. callandra* be treated as a distinct species, instead of a subspecies of *A. selene*, on the basis of various morphological differences, especially between the second instars and the coloration of the wings of the males of the two species.

Key Words: Anacardiaceae, Andamans, island biogeography, *Lannea*, moths, Nicobar Islands, saturniid

Introduction

This paper reports field observations and rearing by the two first authors of the saturniid *Actias callandra* Jordan, **new status**, a large "moon moth" endemic to the Andaman Islands. Since the original description (Jordan 1911: 130), it has been considered by all authors to be a subspecies of *Actias selene* (Hübner), which ranges from Afghanistan to Borneo.

The Andaman and Nicobar Archipelago, consisting of about 324 islands (Snow 1970), is located at the junction of the subducting Indian plate and the Burmese and Southeast Asia plates/platelets (Curray 1989, Hamilton 1989) in the Bay of Bengal in the northeastern Indian Ocean. These islands have not been connected to any of the adjacent continental land masses since at least Pleistocene times. The Andamans and the Nicobars also were not connected with each other during that part of Pleistocene when the sea level was lower (Ripley & Beehler 1989). Consequently each island group harbors a unique biota with a relatively high proportion of endemics. The Andamans are said to have a greater biotic affinity with Burma, while the Nicobars are thought to possess a biota that is derived more broadly from Southeast Asia. Interestingly, the currently known saturniid fauna of these islands conforms to the above biogeographic pattern, although no saturniid has been re-

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corded from the Nicobar Islands. This is a reflection of the uneven collection effort in the two island groups, as the British, who colonized these islands for the second time in the latter half of the 19th century, had their headquarters in Great Andaman (the three contiguous islands of North, Middle and South Andamans, Baratang and Rutland), so most of the serious insect collections made during this period were centered on those islands. With no major colonial settlements in the Nicobars, collecting from these islands has always been minimal. In the post-colonial era, no change was made in the location of the headquarters, so the Indian government has continued to rule the archipelago from Port Blair, South Andaman. In addition, offices of all the major scientific institutions are located at Port Blair, so that even today the biota of the Nicobars remains less studied as compared with that of the Andamans.

Six species of Saturniidae belonging to five genera have so far been recorded from the Andaman Islands, all of which are considered to be endemic to these islands (Peigler 1989). Three of these are endemic species while the other three are presently considered to be endemic only at the subspecific level. The type locality of all these taxa is Port Blair or "South Andaman". Only two species of *Actias* have been recorded from the Andamans, *A. ignescens* Moore, which closely resembles *A. maenas* Doubleday from the Southeast Asian mainland and Greater Sunda Islands of Indonesia, and *Actias callandra*, which has been considered a subspecies of *A. selene* from the mainland (Moore 1877, Hampson 1892, Conte 1918, Peigler 1989). The report by Arora and Gupta (1979) of *A. maenas* (which they assigned to the genus *Sonthonnaxia*) and *A. selene* occurring in the Andaman Islands actually refered to the two endemic species, viz. *A. ignescens* and *A. callandra*, respectively. We are certain of this because the listings by Arora and Gupta under "material examined" show that they did not examine material from the Andamans; they simply were including all "subspecies" of *A. selene* and *A. maenas* as part of the distributions.

All the Andaman saturniids are known only from the adults, except where we recently reported on the life history of *Attacus mcmulleni* J. H. Watson (Veenakumari et al. 1995). No information is available on the immature stages, host plants, or life histories of the other Andaman taxa. We have therefore been trying to fill in this void in our knowledge of the Saturniidae of the Andaman and Nicobar islands. In keeping with this objective we describe below the pre-imaginal stages of *Actias callandra* and outline the life history of this saturniid in the island of South Andaman. The most detailed study to date on the life history of a species in the *Actias* genus-group was carried out by Ylla (1992). Its scope far exceeds any work done for related species in North America, Africa, and Asia, so there remains much to be learned about these large moths which are supposedly "well-known".

Materials and Methods

Adult females of *A. callandra* captured at light at night or resting on foliage in the forest during the day were caught and confined in large transparent plastic jars (9 cm

x 19 cm), or wooden cages (44 x 30 x 30 cm) with sides of glass and wire mesh. Eggs laid by wild females were incubated at ambient temperatures (27 °C) and relative humidity (83%).

Since large numbers of the eggs hatched almost simultaneously, the first two larval instars were reared *en masse* in the large transparent plastic jars (9 cm in diameter, 19 cm high). Subsequent instars were reared individually in similar jars. The tops of the jars were covered with cloth and fastened securely with rubber bands. All frass was removed and the walls of the jars wiped clean with a cloth daily. Simultaneously all old food was removed and the larvae provided with fresh, green leaves of their host plant.

Prior to our having procured the first batch of eggs from a captive female, the only pre-imaginal stage of *A. callandra* that we found was one live cocoon on a plant, as cited below. We therefore fed the newly hatched larvae with leaves from the plant on which we had found this live cocoon. Fortunately the larvae readily accepted these leaves as food. All descriptions were made within a day or two after the larvae molted. Measurements of newly hatched larvae were taken when their rearing containers were being routinely cleaned. The presence of head capsules in the rearing containers indicated that molting had occurred. Larvae in the final instar were provided with a sturdy stick to facilitate cocoon formation. Only rarely did the larvae spin among the leaves against the side of the container.

Voucher material from the rearings is deposited at the Entomology Section, Central Agricultural Research Institute, Port Blair, and the Denver Museum of Natural History, Colorado. In March 1995, the third author studied specimens of *A. callandra* in The Natural History Museum (London). The material consists of seven syntypes, five males and two females, all labelled as coming from Port Blair, without indication of the dates or collector. Two pairs of Jordan's (1911: 131) original syntypes were not located. One male labelled "Type" has a forewing length of 70 mm. An additional series of nine males and five females was reared by J. H. Watson from cocoons he received from W. F. McMullen; this lot also includes five cocoons, a vial of dried ova, and a pupa. One cocoon is labelled "Haddo, Andamans." Some of Watson's material was figured by Packard (1914: pl. 95). Males have a forewing length of 55-70 mm; females 80 mm. Males have a hindwing length of 65-90 mm; females 100-105 mm. The wing coloration of most males is a distinctive deep yellow, quite unlike the pale green in males of *A. selene*, but a few of the males of *A. callandra* appear greenish. This is probably a seasonal color difference (M. M. Collins, pers. comm.); indeed the two yellow males in the Denver Museum of Natural History emerged 21 September 1995 and the green one 22 March 1995. The postmedian lines are very prominent and dark brown in both sexes. The ocelli in each wing are smaller in both sexes of *A. callandra* than in *A. selene*.

Results

Life Cycle. *A. callandra* took from 39 to 61 days to complete its life cycle with a mean duration of 50 days (Table 1). Though we reared through to adulthood only those larvae that emerged from the eggs laid in April, we could find little difference in the duration of the pre-imaginal stages in a comparison among broods begun in the months of April, July, August, September and November. The only durations that did not fall into the ranges of the April brood were for that of the first instar (some of which molted after three days) and the fourth instar (some of which exceeded the

Table 1. Duration and dimensions of the pre-imaginal instars of the April brood of *Actias callandra* in South Andaman Island

	Egg	Larval instars					Pupa
		I	II	III	IV	V	
Duration (days)							
n	8	23	22	24	19	13	6
Mean	11.75	5.30	4.72	4.04	6.31	11.61	18.33
Range	7-15	4-6	3-6	3-5	5-7	9-17	15-20
S.D.	3.33	0.55	0.76	0.46	0.74	2.60	1.86
Dimensions (cm)							
n	20	6	5	17	21	17	10
Mean	3.37 ×2.79	0.73	1.62	2.50	3.81	6.49	6.41 ×3.31
Range	(3.3-3.6) × (2.7-2.8)	0.6-0.8	1.4-1.8	2.2-2.9	3.5-4.0	5.8-7.2	(5.8-7.5) × (2.2-3.8)
S.D.	0.08 ×0.02	0.08	0.17	0.20	0.25	0.49	0.60 ×0.45

Note: For eggs and pupae, dimensions are recorded as length × width

range in Table 1 and molted after 8 days). Even larvae that hatched on the same day varied in the period that they took to complete each of the instars.

Host plant. *Lannea coromandelica* (Houtt.) Merrill (= *Odina wodier* Roxburgh), Anacardiaceae, a deciduous tree with compound (imparipinnate) leaves, was the only host plant on which we reared *A. callandra*. In spite of searching diligently, we rarely found the pre-imaginal stages of this moth on trees in the forest. The finding of one live cocoon on a young *L. coromandelica* tree at Chiriyatapu (S. Andaman) in 1993 gave us the first clue to at least one of the possible food plants of *A. callandra*, finally enabling us to successfully rear *A. callandra* in the laboratory when we obtained eggs from females which were caught at light at night and confined in cages.

In August 1994, we collected one empty cocoon on a shoot of a mangrove (*Rhizophora* sp., Rhizophoraceae). The tree on which this cocoon was found was growing well within a mangrove community. We see very little possibility of a larva having wandered off from some other host plant to pupate on this mangrove tree. Therefore, circumstantial evidence points to *Rhizophora* being another host plant of *A. callandra*, but this needs confirmation.

Phenology. We collected adults at light in the months of April, July, August, September, and November 1993. Adult females collected in all these months laid fertile eggs from which it was possible to rear the larvae that emerged on leaves of *L. coromandelica*. We therefore surmise that *A. callandra* is multivoltine. Since *L. coromandelica* is deciduous in the Andamans, shedding its leaves

Table 2: Measurements (mm) of the head capsules of the first four larval instars of *Actias callandra*

	Larval instars			
	I	II	III	IV
n	4	7	21	11
Mean	1.20	1.68	2.69	4.46
Range	Nil	1.6-1.7	2.5-2.8	4.2-4.6
S.D.	0	0.03	0.09	0.13

in the hot season, *A. callandra* must either pass a short period of diapause or it must use alternate hosts during the period when *L. coromandelica* is leafless.

Description of Immature Stages

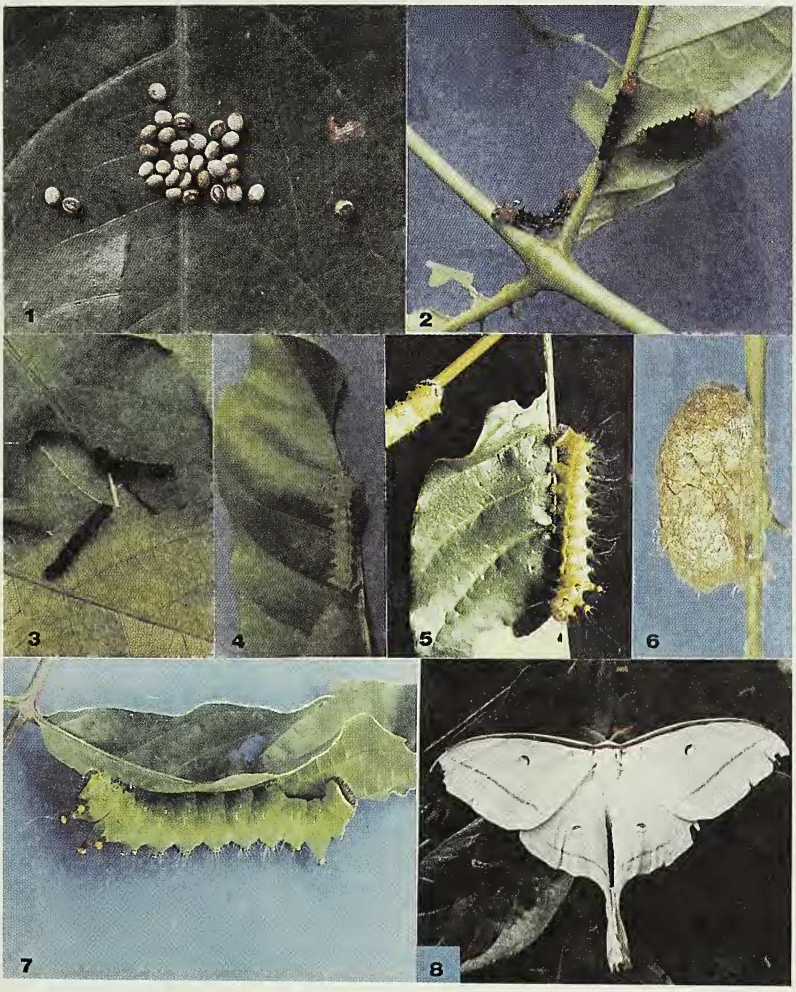
The following descriptions were made from live specimens reared in the laboratory. The first instars were described within 2 days after eclosion, while all the other instars were described within 2-3 days following a molt. The measurements of all the pre-imaginal stages and the cocoon are given in Table 1, and head capsule measurements in Table 2. Specimens in the various stages are shown in Figures 1-8.

Egg. Color dirty white to gray and slightly dorsoventrally flattened. Lower surfaces coated with deep brown encrustations secreted by the females to cement them onto the leaf surface. The first instar larva emerges by making an irregular opening in the micropylar end. The surface of the chorion has a number of small, circular pits, the margins of which are not in contact with each other.

First instar. The head and first 7 abdominal segments black, thoracic segments and posterior abdominal segments from eighth to anal segment orange-brown. Orange color of prothorax brighter than meso- and metathorax. Spiracles black. Setae on dorsal and subdorsal scoli black with 6-10 terminal setae on each scolus. Setae on lateral scoli and head dirty white. Scoli dirty white except those on mesothorax, metathorax and terminal abdominal segments which are a deep yellow-orange, of the same hue as the segment from which they arise. Legs brown along outer surfaces and off-white along inner surfaces. Claws brown. Prolegs off-white with brown crochets, with two black, narrow, annular bands on each proleg. Anal prolegs lacking annular rings. Clypeus and labium off-white; palps off-white proximally and yellow-orange distally.

This and all succeeding instars were observed to rest on the lower surfaces of leaves in the rearing containers.

Second instar. Head glossy black, remainder of larva pale black in color with a discontinuous, darker black mid-dorsal line. Antennae and clypeus off-white; palps brownish. Legs black. Prolegs light brown, with a broad black distal band from which arise small white setae. Anal and lateral plates on each anal proleg deep black with a number of short, whitish setae. Prothoracic



Figs. 1-8. Stages of *Actias callandra* from South Andaman Island, India, shown on *Lannea coromandelica*. 1. Eggs. 2. First instar larvae. 3. Second instar larvae. 4. Third instar larva. 5. Fourth instar larva. 6. Cocoon. 7. Mature (fifth instar) larva. 8. Adult female.

shield with 2 black, stubby scoli directed anteriorly with about 9 long, black, stiff, bristle-like setae on each. Additionally there are 2 lateral scoli with long hair-like setae which are black basally and white to gray for remainder of length. Subdorsal scoli basally fleshy with a more chitinized blackish apical region, on which is situated one central seta surrounded by others. Central seta disproportionately larger than others with basal two-thirds black, terminal third whitish. Dorsal, subdorsal and lateral scoli present on all segments from prothorax to seventh abdominal segment. Sub-lateral or ventro-lateral scoli present however on the three thoracic segments only. Dorsal scoli the most fleshy basally, followed by lateral scoli. Sub-dorsal and sublateral scoli the least fleshy basally. On eighth abdominal segment only one (not two) dorsal scolus present. On ninth abdominal segment only four scoli viz., the dorsal and subdordsal scoli.

Third instar. In this stage larva turns bright green and continues to remain so in all succeeding instars. Prothoracic shield and ventral surface pale green; anal plate brown. Head pale yellow at vertex and in region of frons with remaining portions light brown. Antennae and clypeus off-white; palps brown. Legs brown, with anal prolegs deeper brown. Prolegs proximally green like remainder of body, followed by narrow black band, followed by broader pale yellow band, and terminating distally in a brownish area. Crochets brown. Small, black setae on prolegs. Spiracles brown, with median white longitudinal stripe. All scoli fleshy basally with bulbous terminal crown on which are situated setae of which one is distinctly longer than all others. Meso- and metathoracic scoli with about 11 setae each; all other dorsal scoli with 5-7 each. All short setae on crown of each scolus either completely black or completely brown, with long setae terminally gray with basal two-thirds either black or brown. Sublateral or ventrolateral scoli, situated only on thoracic segments, very small and green like the remainder of body with very few brown setae. Subdorsal and lateral scoli yellow and small. Unlike other dorsal scoli, those on prothorax very small, even smaller than lateral scoli but larger than subdorsal scoli. Dorsal scoli on meso- and metathorax terminally yellow with black band separating green from yellow region. Setae basally green and terminally orange.

Fourth instar. Pale green with region below spiracular line darker green. Head light brown, covered with small white setae. Frons and adjacent areas tinged light green. Legs and claws brown. Prolegs green, concolorous with remainer of body, with broad, deep green band just above crochets which are brown. Anal plate and rear of anal prolegs deep brown with small, white club-shaped protruberances. Spiracles brown with longitudinal white stripe in region where spiracular lips converge.

Fifth instar. Integument composed of various shades of green. Pale green dorsally with intensity of green increasing down lateral surface. Ventral surface deepest green with midventral pale yellow line running across length of body. Prolegs also deep green like ventral surface. A narrow brown semicircular band present on prolegs. Crochets deep brown in color. Rear margins of anal prolegs and anal plate deep brown or rufous. A narrow yellow

band bordering the outer margin, separating green of body from brown of prolegs. The only black setae on prolegs. Legs deep brown or rufous. Head deep brown or rufous with pale yellow frons. Antennae basally greenish yellow, remainder brown. Labium and labial palps yellowish. Spiracles tan to brown with central, longitudinal yellowish stripe where lips converge. Setae on dorsal surface white to gray with those on ventral surface brown and longer. All setae on body surface sparsely distributed, with those on ventral surface being relatively more abundant.

When disturbed, larvae in the last instar tucked their heads into their legs and reared up on their second to anal prolegs adopting a snake-like stance, and swayed fairly rapidly from side to side.

Pupa. Dark brown, with distinct whitish yellow patch on head between compound eyes. (This transparent spot allows light to reach the brain to control diapause; see Miyata 1974, 1986, Nässig & Peigler 1984). Cremaster with hook-like spines.

Cocoon. Initially whitish, papery, and with a distinct sheen, later taking on off-white or dirty white appearance. Spun with its sides adhering to the laminae of the leaves, but always anchored along its length to a twig. Loose strands of silk sometimes on surface. When handled the pupa moves about vigorously. Watson (1911) stated, the "pure white and most lustrous" silk of this species is "valuable". Cocoons of *Actias* are often pure white when formed in captivity, probably due to reduced light or moisture during spinning. Moisture can change cocoons from white to brown in certain Saturniinae (M. M. Collins, pers. comm.). Some of the cocoons of *A. callandra* in The Natural History Museum are pale tan. The papery cocoons of the genus *Actias* are of little or no value sericulturally (Deodikar et al. 1969; Peigler, unpubl.). After adult emergence, the mean dry weight of the cocoon (inclusive of pupal case) was 0.81 + 0.26 g (n = 4; range 0.47 - 1.10 g). A cocoon containing a live pupa weighed 6.78 g (n = 1).

Adult behavior. The only wild adult that we caught was a fecund female at about 1100 hours. It was resting on the undersurface of a leaf of *Licuala* sp. (Arecaceae), an understory palm in the forest at Lohabarak, South Andaman. During the course of rearing it was found that both males and females emerged from cocoons in the evening. One male was observed to emerge at 1700 hours, and a female at 1900 hours.

Disease. During the laboratory rearing of *A. callandra* a number of the larvae succumbed to a disease. Although we did not get the pathogen(s) identified the symptoms point to a virus. The larvae lost their turdigity and became sluggish. Infected larvae produced a dark brown ooze and hung with their heads down.

Discussion

A. callandra has been treated by all authors as a subspecies of *A. selene* (Hampson 1892, Peigler 1989). This study casts doubt on the validity of this status. The second instar larva of *A. callandra* is markedly different in color from the second instar larva of *A. selene*, as described from Hong Kong (Potter

1941) and from Mussorie, India (Cotes 1891-93). While *A. callandra* in this instar is totally black, *A. selene* is orange or rufous and black (Lampe 1984, Heppner et al. 1988). The fact that the Andamans are oceanic islands that were closer to Asia during times of Pleistocene sea level lowering (Ripley & Beehler 1989) lends credence to the supposition that founder individuals (fecund females) reached these islands and speciation resulted from isolation from mainland populations.

The known host plants are different for the two species, although Anacardiaceae is well known to be used by the *Actias* group (Nässig & Peigler 1984). As cited above, *A. callandra* feeds on *Lannea coromandelica*, an anacardiaceous tree. *Actias selene* has been reported to feed on *Zanthoxylum acanthopodium*DC., *Z. alatum*Roxb. (Rutaceae), *Cedrela paniculata* (Meliaceae), *Coriaria nepalensis* Wall. (Coriariaceae), wild cherry (*Prunus*), wild pear (*Pyrus*) (both Rosaceae), walnut (Juglandaceae) and other fruit trees in northern India (Cotes 1891-93, Barlow 1982), while it has been reported to feed on *Heptapleurum octophyllum* Benth.& Hook. f. (Araliaceae) in Hong Kong (Potter 1941, cited as *Octophyllum heptapleuron*).

In Sikkim *A. selene* is reported to pass through two generations in summer, overwintering as a pupa (Cotes 1891-93). It is probable that *A. callandra*, in the more equitable climate of the Andaman Islands, breeds during most months. The species possibly goes through a period of diapause as a pupa during the period when its deciduous food plant sheds its leaves, but more likely, feeds on alternate hosts still unknown to us.

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